ligand. In some embodiments, the multi-dentate ligand comprises at least one carboxylate functional group. In some embodiments, the multi-dentate ligand comprises at least one heterocyclic group having at least one ring nitrogen. In further embodiments, the multi-dentate ligand comprises formic acid, acetic acid, oxalic acid, propanoic acid, butanedioic acid, (E)-butenedioic acid, benzene-1,4-dicarboxylic acid, benzene-1,3-dicarboxylic acid, benzene-1,3,5-tricarboxylic acid, 2-amino-1,4-benzenedicarboxylic acid, 2-bromo-1,4-benzenedicarboxylic acid, biphenyl-4,4'-dicarboxylic acid, biphenyl-3,3',5,5'-tetracarboxylic acid, biphenyl-3,4',5-tricarboxylic acid, 2,5-dihydroxy-1,4-benzenedicarboxylic acid, 1,3,5-tris(4-carboxyphenyl)benzene, (2E, 4E)-hexa-2,4-dienedioic acid, 1,4-naphthalenedicarboxylic acid, pyrene-2,7-dicarboxylic acid, 4,5,9,10-tetrahydropyrene-2,7-dicarboxylic acid, aspartic acid, glutamic acid, adenine, 4,4'-bypiridine, pyrimidine, pyrazine, pyridine-4-carboxylic acid, pyridine-3-carboxylic acid, imidazole, 1H-benzimidazole, 2-methyl-1H-imidazole, or a mixture thereof. In some embodiments, the multi-dentate ligand comprises terephthalic acid (H_2BDC), 2,2'-bipyridine-5,5'-dicarboxylic acid (H_2BPY), 2',5'-bis(azidomethyl)-[1,1':4', 1"-terphenyl]-4,4"-dicarboxylic acid, ($H_2TPDC\text{-}N_3$), 4,4', 4",4"'-porphyrin tetrabenzoic acid (H_2TCPP), or a combination thereof. In further embodiments, the metal ion comprises a 12-connect Zr_3 cluster, a 6-connect Zr_3 cluster, a 8-connect Zr_3 cluster, a Cr_3 cluster, a Fe_3 cluster, a Al_3 cluster, or a combination thereof. In still further embodiments, the method further comprises the step, prior to step (b), of contacting the MOF nanoparticle with the agent thereby encapsulating the agent in the nanoparticle. In some embodiments, the method further comprises step (d): adding a salt solution to the oligonucleotide-functionalized MOF nanoparticle, wherein step (d) is after step (c). In some embodiments, the salt solution is added to a final concentration of 0.5 M. In yet further embodiments, the method further comprises step (e): contacting the oligonucleotide-functionalized MOF nanoparticle with one or more nanoparticles, wherein each of the one or more nanoparticles comprises an oligonucleotide that is sufficiently complementary to hybridize to the oligonucleotide on the surface of the oligonucleotide-functionalized MOF nanoparticle, and wherein step (e) is after step (d).

[0011] In some aspects a method of inhibiting expression of a gene is provided comprising hybridizing a target polynucleotide encoding the gene with one or more oligonucleotides complementary to all or a portion of the target polynucleotide, the oligonucleotide being the terminal phosphate-modified oligonucleotide of a nanoparticle of the disclosure, wherein hybridizing between the target polynucleotide and the terminal phosphate-modified oligonucleotide occurs over a length of the target polynucleotide with a degree of complementarity sufficient to inhibit expression of the gene product. In some embodiments, expression of the gene product is inhibited in vivo. In some embodiments, expression of the gene product is inhibited in vitro.

[0012] In some aspects, the disclosure provides a method for up-regulating activity of a toll-like receptor (TLR) comprising contacting a cell having the TLR with a nanoparticle of the disclosure. In some embodiments, the terminal phosphate-modified oligonucleotide comprises a TLR agonist. In further embodiments, the TLR is chosen from the group consisting of toll-like receptor 1 (TLR1), toll-like receptor 2 (TLR2), toll-like receptor 3 (TLR3), toll-like receptor 4 (TLR4), toll-like receptor 5 (TLR5), toll-like receptor 6 (TLR6), toll-like receptor 7 (TLR7), toll-like receptor 8 (TLR8), toll-like receptor 9 (TLR9), toll-like receptor 10 (TLR10), toll-like receptor 11 (TLR11), toll-like receptor 12 (TLR12), and toll-like receptor 13 (TLR13). In some embodiments, the method is performed in vitro. In some embodiments, the method is performed in vivo.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. **1** depicts (a) Schematic representation of solvothermal synthesis of UiO-66 MOF nanoparticles[a]; (b) DNA modification of MOFs, utilizing terminal phosphate-modified DNA and subsequent sequence-specific assembly of MOF-NP core-satellite hybrid architectures.

[0014] FIG. **2** depicts the characterization of DNA functionalized MOF nanoparticles: (a) SEM of UiO-66 and (b) TEM images of DNA functionalized UiO66. (c) 31P{1H} SSNMR spectra of phosphate functionalized oligonucleotide. Inset: three phosphorus resonances corresponding to unbound phosphodiester (blue), side on Zr bound phosphodiester (gray) and Zr bound terminal phosphate (red). (d) PXRD of simulated UiO-66 (black), 225 nm UiO-66 before (red) and after (blue) DNA functionalization. (e) Melting transition of MOF and 50 nm gold nanoparticle aggregates assembled with complementary DNA. Scale bar=500 nm in panel a and 2 μm in panel b.

[0015] FIG. **3** shows the library of nine MOFs synthesized and further functionalized with DNA. To systematically investigate factors affecting DNA surface coverage, (a) organic linker length, (b) metal node connectivity, and (c) type of metal cluster were independently and deliberately varied and DNA surface coverage was plotted against surface SBU density, SBU coordination number, and M-O bond dissociation energy. Scale bar=200 nm.

[0016] FIG. **4** depicts PXRD spectra of UiO-66, UiO-67-bpy and $UiO\text{-}68\text{-}N_3$.

[0017] FIG. **5** shows PXRD spectra of PCN-222, PCN-223 and PCN-224.

[0018] FIG. **6** shows PXRD spectra of MIL-101(Cr), MIL-101(Fe) and MIL-101(Al).

[0019] FIG. **7** shows SEM and TEM images of (a) UiO-66 (225±35 nm); (b) UiO-67-bpy (173±19 nm); and (c) $UiO\text{-}68\text{-}N_3$/PCN-58 (148±39 nm).

[0020] FIG. **8** shows SEM and TEM images of (a) PCN-222 (195×48 nm); (b) PCN-223 (538×48 nm); and (c) PCN-224 (110±24 nm).

[0021] FIG. **9** shows SEM and TEM images of (a) MIL-101(Cr) (78±16 nm); (b) MIL-101(Fe) (470±57 nm); and (c) MIL-101(Al) (434±86 nm).

[0022] FIG. **10** shows TEM and EDX characterization of DNA interconnected MOF NP—Au NP assemblies. (a) Representative HAADF image of nanoclusters formed from complementary 225 nm DNA-UiO-66 MOF NPs and 20 nm DNA-Au NPs. Inset: schematic illustration of a MOF NP—AuNP cluster, and a single nanocluster. (b) TEM images of nanocluster assemblies demonstrating how the programmable DNA ligands on MOF NPs and AuNPs provide control over the structural makeup of the assemblies (Au NP size and MOF-to-Au NP stoichiometry). All scale bars are 100 nm, except for in panel a, where it is 1 μm.

[0023] FIG. **11** shows TEM images of 225 nm DNA modified MOF NP core assembled with complementary DNA-modified AuNPs of various shapes: (a) spherical